Project Proposal: K-SVD Denoising Algorithm via Sparse and Redundant Dictionary Learning

Project Overview

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Project team: Aditya Banerjee (M.tech AI), Shreeya Garg (M.tech AI)

Introduction

Image denoising is a critical task in computer vision and image processing, with applications ranging from medical image analysis to surveillance systems. The K-SVD denoising algorithm, which is based on sparse and redundant dictionary learning, has shown promise in effectively removing noise from images, with . This project aims to investigate and optimize the performance of the K-SVD denoising algorithm by exploring the impact of various factors such as datasets, dictionary learning, and decomposition methods.

Objectives

Evaluate the performance of the K-SVD denoising algorithm on different datasets to identify which datasets yield better results and understand the properties that contribute to this performance difference.

Investigate the effect of varying dictionary sizes (K) on the denoising performance, determining the optimal K value for different types of images.

Analyze the performance of different SVD decomposition approaches, such as power method and others, to understand the trade-offs between speed and accuracy in the context of the K-SVD algorithm.

Methodology

1. Dataset Analysis

1. Collect a diverse set of image datasets for evaluation.
2. Apply the K-SVD denoising algorithm to each dataset.
3. Measure and compare the denoising performance using standard metrics.

2. K Effect Analysis

1. Perform denoising experiments on selected datasets using varying dictionary sizes (K).
2. Analyze the trade-offs between computational complexity and denoising quality at different K values.

3. SVD Decomposition Analysis

1. Investigate different SVD decomposition methods, such as power method and randomized SVD.
2. Compare the speed and accuracy of denoising achieved with various SVD decomposition approaches.
3. Identify which decomposition method is best suited for real-time or resource-constrained applications.

Expected Outcomes

1. Build an understanding of the impact of different datasets on the K-SVD denoising algorithm's performance.
2. Guidelines for selecting the optimal dictionary size (K) for different image denoising tasks.
3. Insights into the trade-offs between speed and accuracy when using different SVD decomposition methods.

References

1. Elad, M., & Aharon, M. (2006). Image denoising via sparse and redundant representation over learned dictionaries.
2. Aharon, M., Elad, M., & Bruckstein, A. (2006). K-SVD: An algorithm for designing overcomplete dictionaries for sparse representation.